

# Multi-analyte, Single-Fiber, Optical Sensor

*In situ measurement of multiple chemical substances, saving time and expense*

**F**iber-optic sensors offer tremendous potential for remote and in situ measurement of contamination. Current methods for detecting nearly all priority contaminants require samples to be collected and submitted for laboratory analysis, which can take up to 30 days to get results. Optical sensors allow in situ measurement of contamination in real time, saving both time and expense. However, the current state-of-the-art in sensor technology is single-fiber sensors that can detect single compounds. Many DOE sites have dozens, if not hundreds, of pollutant compounds present.

We have collaborated with Tufts University to demonstrate a unique technology that enables up to 20 different sensors to be placed in a single, 350-micrometer-diameter optical fiber to measure the concentrations of various chemical constituents.

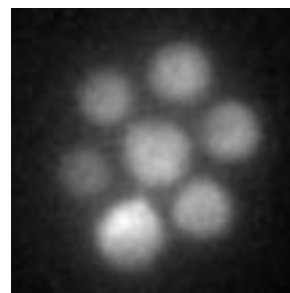
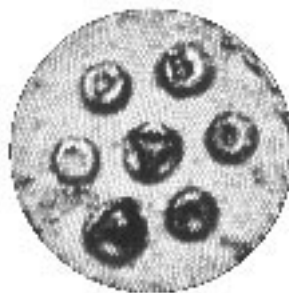
## Unaffected by common interferences

Optical fibers can be used where high levels of radiation, magnetic fluxes, or temperature variation exist because they are unaffected by such interferences. The fiber-optic array offers the

potential for single rapid or portable multianalyte screening and monitoring of mixed wastes at DOE installations. The unique multiplexing of this sensor allows a single instrument to measure more than one compound to the parts per million level.

Sensing regions are placed at precise locations on the end of an imaging optical fiber, and

the signals from each region are monitored simultaneously. The imaging fibers contain several thousand discrete light-transmitting channels that coherently relay an image from one end to the other. The sensors are designed to fluoresce when illuminated by light at a particular excitation wavelength. Each individual sensor



(a) Microphotograph of a successful deposition of seven individual sensing elements on a single 350-micrometer-diameter imaging fiber. The individual 6-micrometer channels of the imaging fiber are partially visible. (b) Image from a charge-coupled device detector showing fluorescence signals from the sensor shown in (a).

changes its fluorescence intensity according to changes in the concentration of a particular chemical substance.

## Recent work

A portable, low-cost instrument has been designed and built to make useful field measurements using multi-analyte fiber sensors. Field tests are scheduled for this instrument in 1995. The suite of compounds to be measured will be chosen to match the application. In addition to measuring pH and the presence of hydrocarbons, we are considering a bioremediation application in which  $O_2$  and  $CO_2$  sensors would help monitor the life signs of microorganisms.

**Availability:** Our application-specific technology is available for field-of-use licensing. We have established informal collaborations with several instrument component manufacturers and welcome discussions with other potential partners.

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## APPLICATIONS

- Remote and in situ measurement of chemical compounds
- Multiple sensors to be placed in a single optical fiber to detect various chemical compounds
- Use where high levels of radiation, magnetic fluxes, or temperature variation exist